Journal of Tropical Agriculture 34 (1996) : 44-47

EFFECT OF WATER MANAGEMENT AND LIME ON IRON TOXICITY AND YIELD OF PADDY

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Abstract : A field experiment was conducted during rabi and summer seasons of 1991-92 in paddy fields of Chalakudy Command Area, in order to study the effect of a single top dressing of lime on iron toxicity and yield of paddy under different water management practices. Considerable reduction in Fe' * concentration could be noticed in soil as well as plant during the period of panicle initiation when lime was applied entirely as one top dressing (at 20 days after transplanting or 30 days after sowing). Application of lime 9 500 kg ha^{-1} as single top dressing resulted significantly higher grain and straw yields of paddy as compared to lime @ 300 kg ha^{-1}, 900 kg ha^{-1} and no lime application. The economic level of lime for getting maximum profit from grain and straw was 568 kg ha^{-1} and 635 kg ha^{-1} for the rabi and summer crops respectively.

Key words: Iron toxicity, lime, rice, water management.

INTRODUCTION

Iron toxicity is a major problem in the rice fields of Chalakudy Command Area during rabi and summer seasons. Available iron in these soils ranged from 1000-3000 ppm. As reported by Anilakumar (1979), lime application is helpful in minimising the Fe and Al solubilization at toxic concentrations. Ameliorants are more and more realised to be used coupled with washing (Marykutty and Aiyer, 1987). As per the recommendations of the Kerala Agricultural University (KAU, 1989) the rate of lime application for paddy is 600 kg ha^{-1} of which 350 kg ha^{-1} has to be applied at the time of planting and the rest 250 kg ha^{-1} one month after sowing or transplanting. Since lime is a costly input, it has to be applied in such a way that at least the production phase of the rice plant will be saved from the ill-effects of excess iron. Hence the present study was taken up with a view to find out the effect of single top dressing of lime on iron toxicity and yield of paddy under different water management practices and also to work out the optimum and economic dose for single application of lime for paddy in this area.

MATERIALS AND METHODS

A field experiment was conducted during rabi and summer seasons of 1991-92, in the paddy fields of "on farm water management area" (farmers field) at Mookannur, about 20 km away from Chalakudy. The initial soil characteristics are given in Table 1. The experiment was conducted in split plot design with three replications. Main plot treatments consisted of two levels of irrigation viz., continuous submergence (I_1) and 5 ± 2 cm irrigation one day after the disappearance of ponded water (I_2). Subplot treatments consisted of four levels of lime viz., 0 kg ha^{-1} (I_0), 300 kg ha^{-1} (I_1), 600 kg ha^{-1} (I_2) and 900 kg ha^{-1} (I_3) applied as single top dressing at 20 days after transplanting or one month after sowing. As the study was taken up in farmer's field, the subplot treatments were applied to large plots with an area of 800 m^2. The rice varieties grown were Chitteni (local) and Red Triveni during rabi and summer respectively.

Wet soil samples were drawn before the application of lime and periodically at 20 days interval after the application of lime for

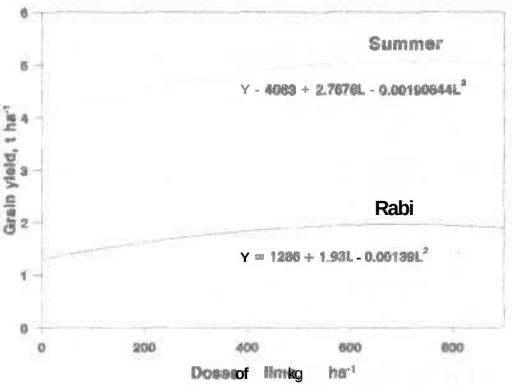

Fig 1. Grain yield of paddy as **influenced** by single top dressing of lime

Table 1. Initial soil characteristics

Texture	Sandy loam
PH	5.6
EC (dS m^{-1})	0.3
Organic Carbon, %	1.21
Available P, pptn	12.5
Available K, ppm	52.5
Available Fe^{++}, ppm in wet soil	1899 (range 1000-3000)

determining the fluctuations in the soluble iron concentration in the soil. Plant samples were taken at 20 days after liming for determining the iron content in the plant. The method suggested by Dewis and Freitas (1984) was used for iron determination.

The optimum and economic doses for single application of lime were computed using the formulae; L opt = -b/2c and L econ = q/p-b/2c where b and c are obtained from the second degree function of lime for grain yield Y = a + bL + cL^2 + e (where e = residue, p = price of input and q = price of output).

RESULTS AND DISCUSSION

Effect of single top dressing of lime on the grain and straw yields of rice under different irrigation treatments

Statistical analysis of the yield data had shown that lime application could influence the grain as well as straw yields of paddy, positively and significantly during both the seasons (Table 2 and 3). The yield of paddy (both grain and straw) was maximum when lime was applied @ 600 kg ha^{-1} and it was on par with lime @ 900 kg ha^{-1}. These two treatments were significantly superior to lime @ 300 kg ha^{-1} and no lime application. The effect of irrigation and the interaction of lime and irrigation on the grain yield of paddy were not significant either in rabi or summer. However, continuous flow submergence (I_1) recorded higher yield (both grain and straw) than 5 ± 2 cm irrigation one day after the disappearnace of ponded water (I_3) during both the seasons.

Effect of liming on the Fe^{++} content in soil and rice plant

During both the seasons, considerable reduction in soil Fe" concentration was noticed in the plots where lime was applied (Table 4) especially at 20 days after liming. Fluctuations in the soil Fe^{++} concentration due to liming was more during summer than in the rabi season.

Tanaka and Yoshida (1970) have fixed 300 ppm of iron as upper critical level of iron in leaf blade. It has been reported that the most critical component of yield in laterite soil is continuous absorption as well as accumulation of iron in the leaf blade which often goes beyond the upper critical level of 300 ppm (Bridgit *et al.*, 1992; Potty *et al.*, 1992). It was also indicated that varieties manifest variations in the absorption and accumulation of iron. Rice varieties viz., Red Triveni and Aswathi recorded 1800 and 940 ppm iron respectively at the active tillering stage (Bridgit *et al.*, 1992). High yielding varieties of rice were more susceptible to Fe toxicity, causing considerable reduction in yield. The traditional tall *indicas* were resistant to excess soil Fe (Elsy *et al.*,1994). Hence, in the present study, iron content in the leaves of rice plant (var. Red Triveni) in different treatments was estimated. Since the iron content in the soil was reduced to the maximum extent at 20 days after liming which coincided with

Table 2. Grain yield of paddy (kg ha ^{1}) as influenced by irrigation and lime application

Treatments	Rabi 199!			Summer 1992		
Levels of lime	Levels of irrigation		Mean	Levels of irrigation		Mean
	I_1	I_2		I_1	I_2	
I_0	1243	1380	1312	4379	3836	4108
I_1	1722	1601	1662	5046	4128	4587
1,	2202	1843	2023	5296	5046	5171
T_3	2123	1622	1873	5171	4754	4963
Mean	1823	1612	-	4973	4441	-
CD (0.05) for lime : 249,25 ,, irrigation : NS ,, interaction : NS				CD (0.05) for lime : 383.38 ,, irrigation : NS ,, interaction : NS		

Table 3. Straw yield of paddy (kg ha ') as influenced by lime and irrigation

Treatments	Rabi 1991			Summer 1992		
Levels of lime	Levels of irrigation		Mean	Levels of irrigation		Mean
	I_1	I_2		I,	I_2	
I_0	1889	2218	2054	5079	4170	4625
1,	2523	2556	2540	5463	4796	5130
1,	3903	3469	3686	6172	5838	6005
T,	3678	2189	2934	6005	•5421	5713
Mean	2998	2608	-	5679	5056	-
CD (0.05) for lime : 668.88 ,, irrigation : 327 ,, interaction : NS				. CD (0.05) for lime : 405.56 ,, irrigation : NS ,, interaction: NS		

the panicle initiation stage, iron concentration in the rice plant was determined at this stage of growth. The data indicated that by the application of lime @ 600 kg ha^{-1}, Fe^{++} concentration in the plant could he reduced up to 44% over control during the panicle initiation stage (Table 5). The increased yield obtained by the application of lime is correlated well with the decreased Fe content in the rice plant, the correlation values being -0.825 and -0.894 for grain and straw yield respectively.

Optimum and economic dose for single top dressing lime

Equation for the quadratic response curve was obtained as given below:

$Y = 1286 + 1.93\ L - 1.39 \times 10^{-3} L^2$ (Rabi crop)
$Y = 4063 + 2.7676\ L - 1.90844 \times 10^{-3} L^2$ (Summer crop)

In both the seasons response pattern remained the same (Fig. 1).

The L opt which is the yield maximising level of lime was calculated as 725 and 696 kg ha^{-1} for the summer and rabi crops, respectively. As far as the paddy growers are concerned, the economic dose (L econ) is more important than the yield maximising level (L opt). The L econ worked out for the rabi crop was 550 kg and that for the summer crop was 620 kg ha^{-1}.

Table 4. Fe" (ppm) in the soil

Treatment		Fe in ppm at different periods of sampling			
		Before liming	20 DAL*	40 DAL	60 DAL
		A. *Rabi*			
I_1	I_0	1835	2088	1576	1790
	I_1	1237	1174	1206	2302
	I_2	2492	1631	2440	2326
	I_3	1687	1158	1997	3159
I_2	I_0	1287	929	1660	1631
	I_1	1390	1049	1799	2665
	I_2	1628	1357	1223	2307
	I_3	2083	1796	1189	2572"
		B. *Summer*			
I_1	I_0	1572	1533	1563	884
	I_1	1803	1410	1235	515
	I_2	1250	971	967	576
	I_3	1675	872	1165	529
I_2	I_0	1556	1671	1595	1313
	I_1	2388	2026	1937	1300
	I_2	2115	1628 7	1961	828
	I_3	3228	2256	1957	1034

* DAL - Days after liming

Table 5. Fe^{++} content (ppm) in the rice plant as influenced by irrigation and lime application during summer 1992

Levels of lime	Levels of irrigation			% reduction over control
	I_1	I_2	Mean	
I_0	983	1375	1179	-
I_1	856	828	842	29
I_2	613	707	660	44
I_3	427	923	675	43
Mean	720	958"	-	-

While considering the total profit from grain and straw, the economic level of lime for getting the maximum profit was 568 kg ha^{-1} and 635 kg ha^{-1} for the rabi and summer crops respectively.

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